The Antikythera Mechanism on the OLPC

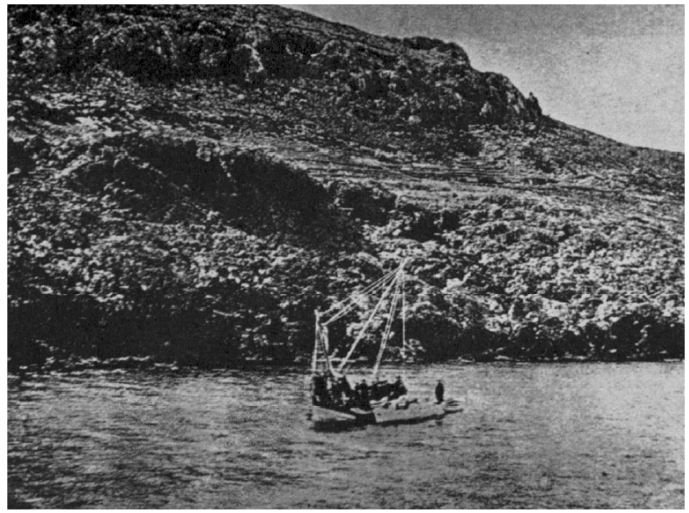
Diomidis Spinellis
Associate Professor
Information Systems Technology Laboratory
Athens University of Economics and Business
http://www.dmst.aueb.gr/dds

Overview

- Overview of the Antikythera Mechanism
- OLPC initiative
- OLPC platform
- Squeak and EToys
- EToys implementation

Antikythera Mechanism

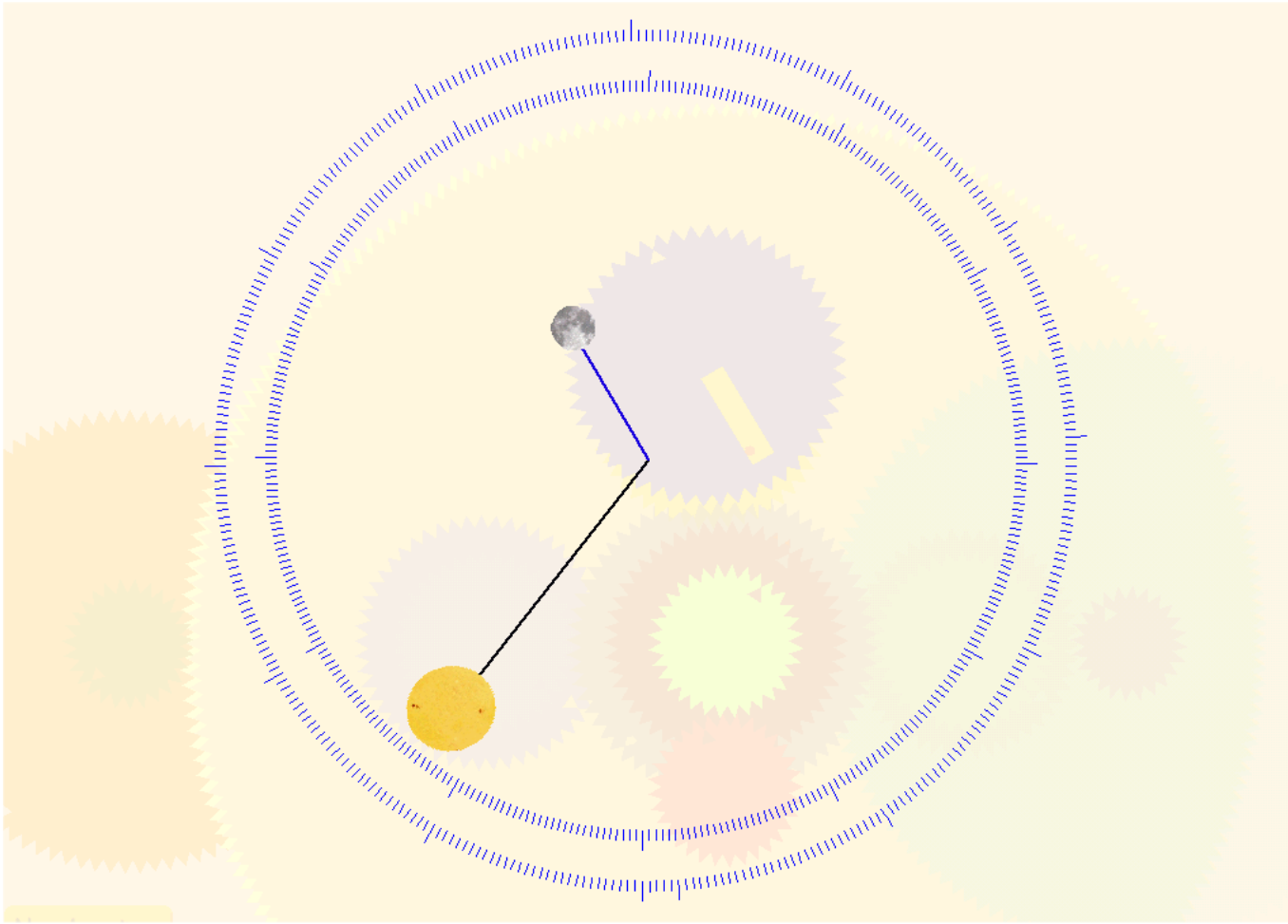
- Discovered 1900
- Dated 150-100 B.C.
- At least 35 gears
- Astronomical calculator
- Studies
  - D. de Solla Price (1960)
  - Nature (2006)



Front Dial Function

- Sun Zodiac position
- Moon Zodiac position (anomalistic month)
- Moon phase

Front Dial



Luni-Solar Calendar

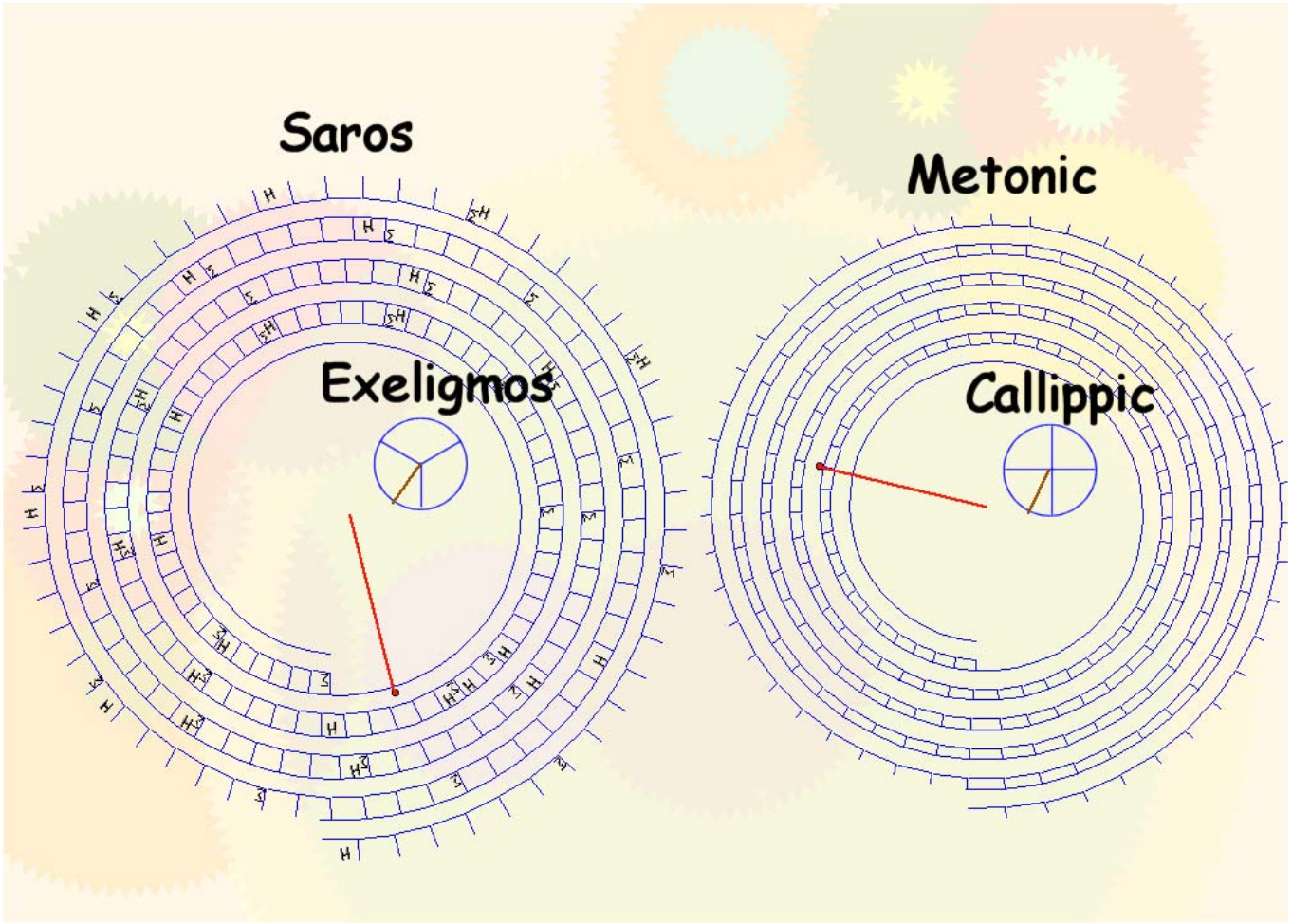
- Meton
  - 29 ½ day synodic month
  - 19 seasonal years contain almost 235 synodic months
- Callipus
  - cycle containing 125 full months of 30 days
  - 110 hollow, 29 day, months

Eclipse Prediction

- Saros cycle
  - 223 ⅓ synodic months
- Exeligmos
  - Three Saros cycles

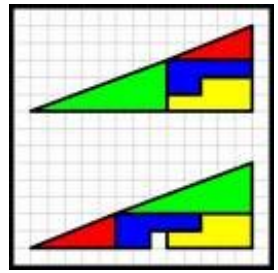
- Software engineering
  - Lookup table
  - Design pattern for increasing the resolution

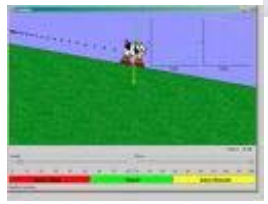
Back Dial

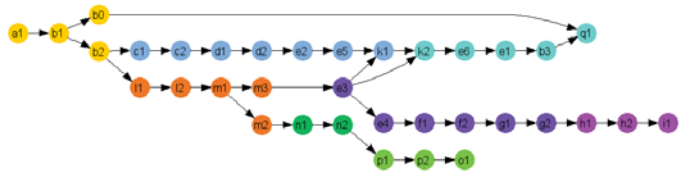


Educational Context

- Astronomy
- Arithmetic
- Geometry
- Mechanical engineering
- Physics
- Archeology
- Computer science
- Science







One Laptop per Child

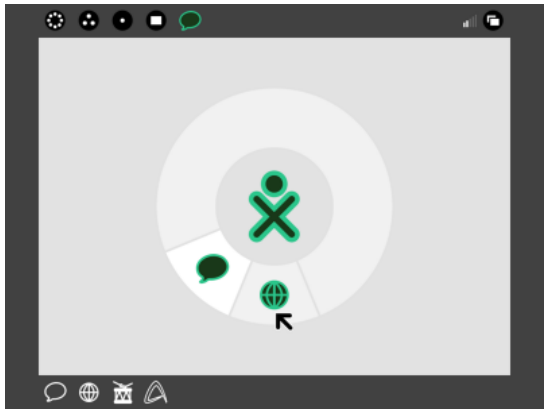
- Computers are tools
- Imagine a writing lab…
- Build an affordable machine tailored to children
- OLPC as an enabler
  - Learn by doing
  - Experiment
  - Communicate and collaborate
  - Access knowledge

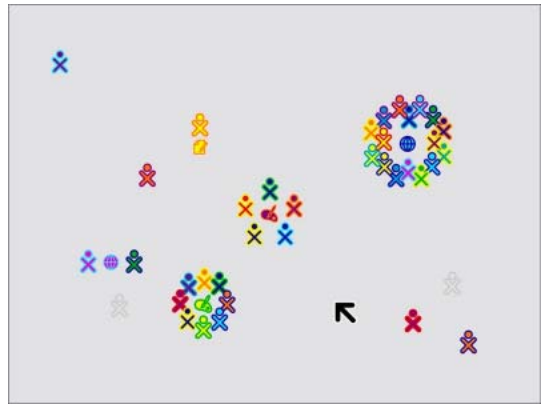
Platform Overview

- Sturdy
  - No hard disk
  - Spill proof keyboard
- Thrifty on power consumption
- Size, weight, form suitable for children
- 1200×900 screen readable under the sunlight
- Book mode
- Mesh networking
- I/O for experiments

Software Overview

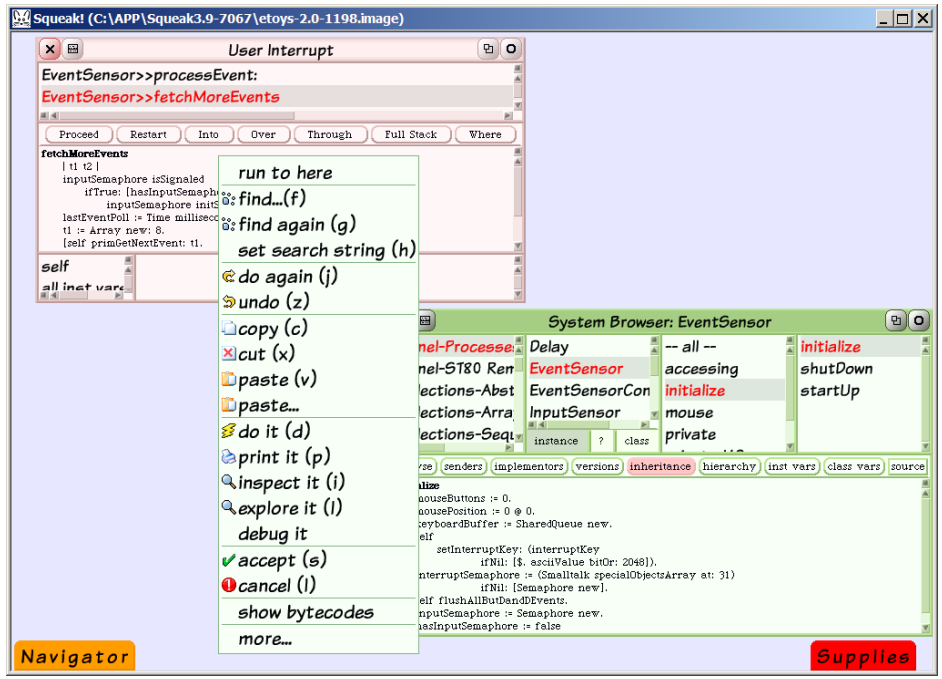
- Linux
- X11
- Sugar
  - Web browser
  - Paint
  - Write
  - Slideshow
  - Camera
  - Tam-tam
  - Squeak EToys





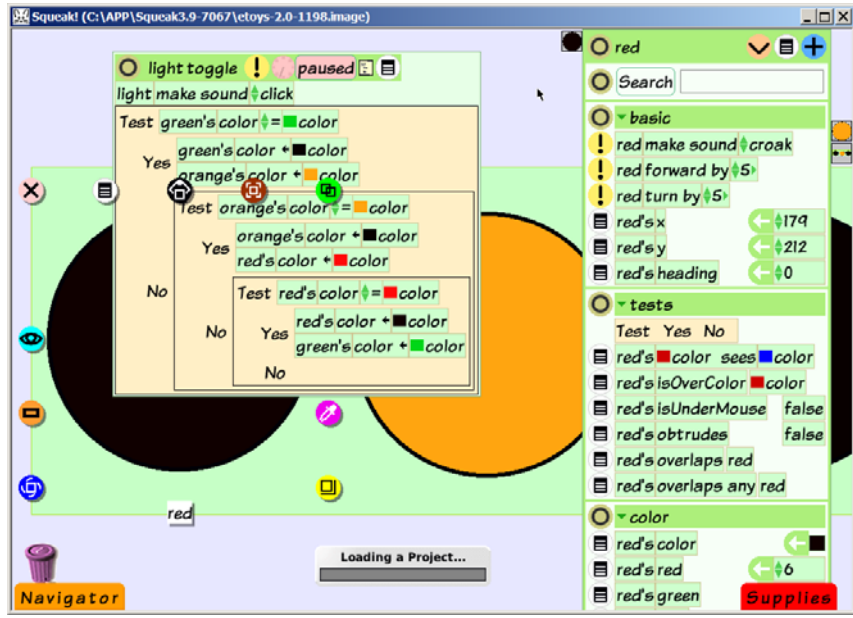
Squeak

- Smalltalk in the 21st century
- Re-implementation of Smalltalk in Smalltalk
- VM-based
- Runs bit-identical images on any platform



EToys

- Visual programming environment
- Built on top of Squeak
- Suitable for
  - building learning activities
  - learning by doing



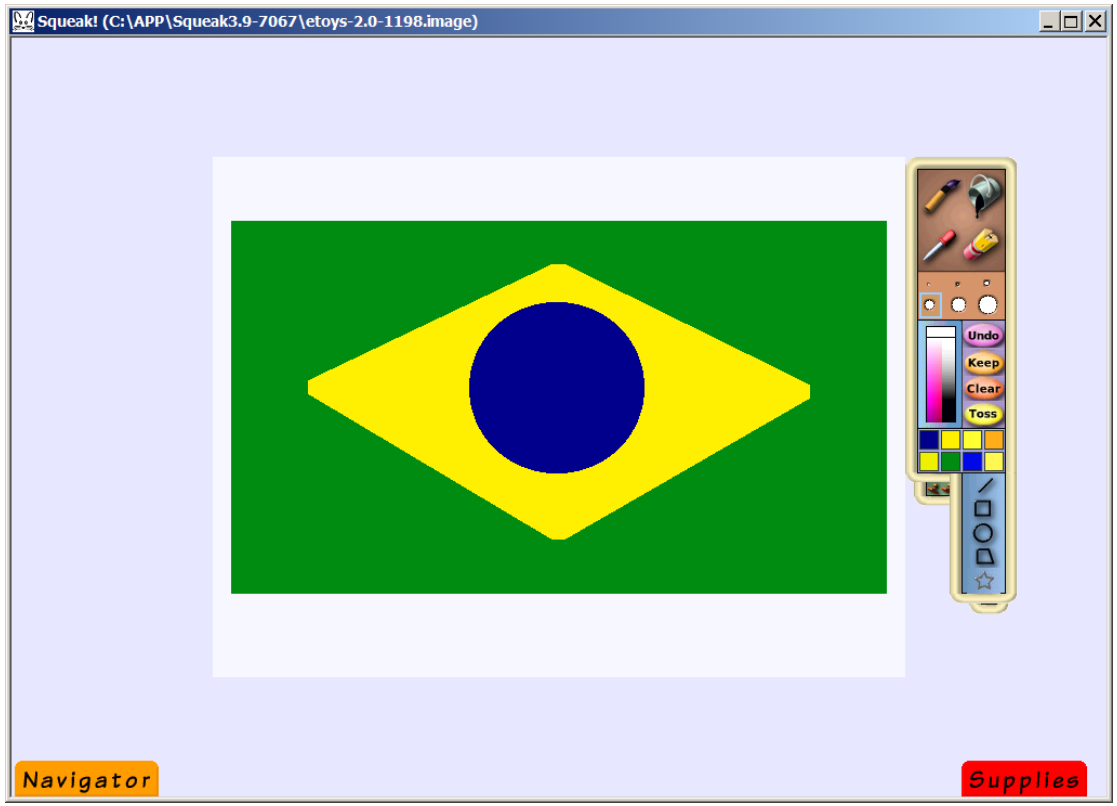
Basic Idea

- One interface mechanism
  - Available everywhere
  - Controlling everything

- No distinction between producers and consumers
  - Children can explore and change what they're seeing

A Simple Example

- Let’s draw a flag

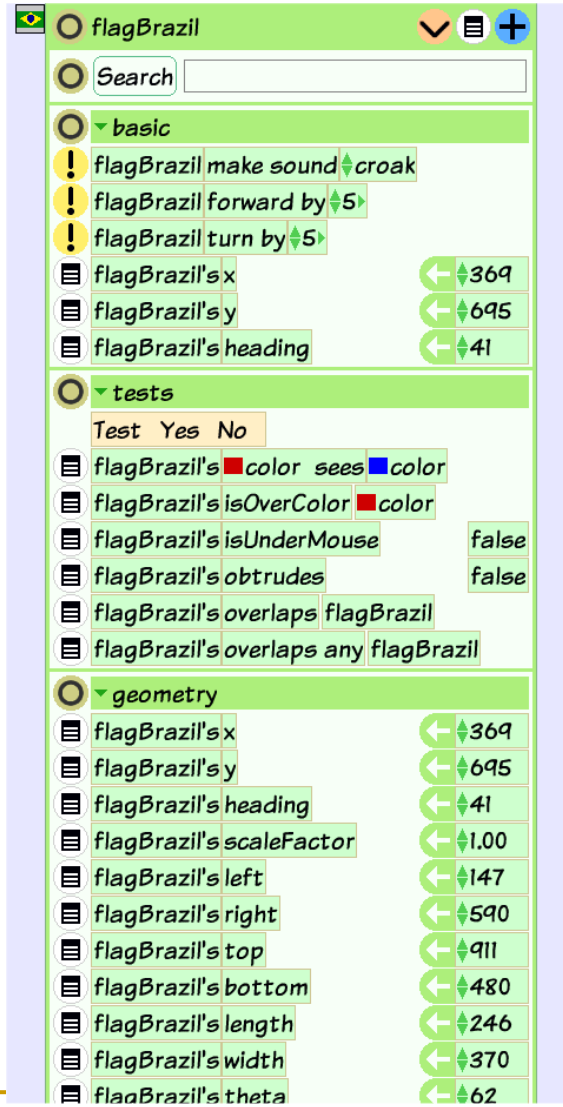


Processing

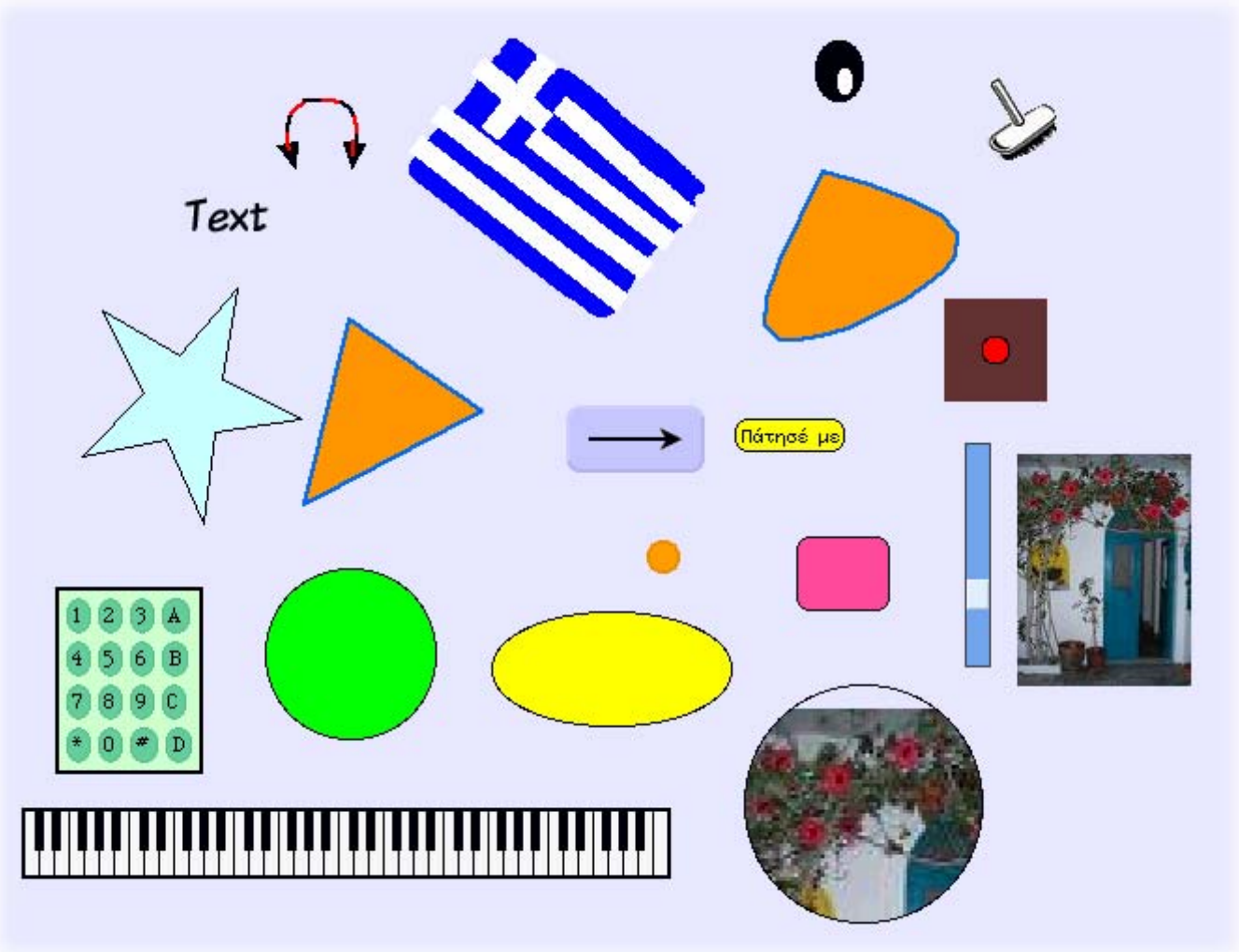

flagBrazil


flagBrazil


flagBrazil


flagBrazil
Search
basic
flagBrazil make sound croak
flagBrazil forward by 5
flagBrazil turn by 5
flagBrazil's x 369
flagBrazil's y 695
flagBrazil's heading 41
tests
Test Yes No
flagBrazil's color sees color
flagBrazil's isOverColor color
flagBrazil's isUnderMouse false
flagBrazil's obtrudes false
flagBrazil's overlaps flagBrazil
flagBrazil's overlaps any flagBrazil
geometry
flagBrazil's x 369
flagBrazil's y 695
flagBrazil's heading 41
flagBrazil's scaleFactor 1.00
flagBrazil's left 147
flagBrazil's right 590
flagBrazil's top 911
flagBrazil's bottom 480
flagBrazil's length 246
flagBrazil's width 370
flagBrazil's theta 62

A Student's Toolbox



Programming

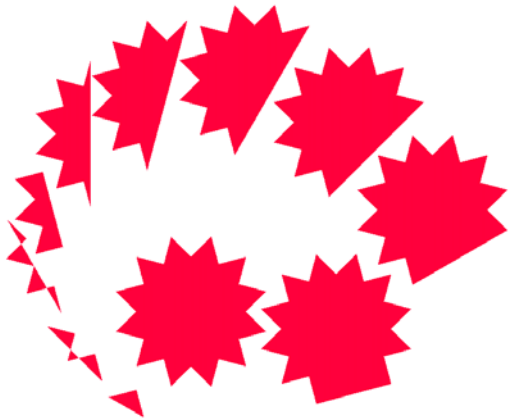
- Everything is an object
- All objects have similar properties
- We can modify properties by direct manipulation
- Programming is the changing of properties

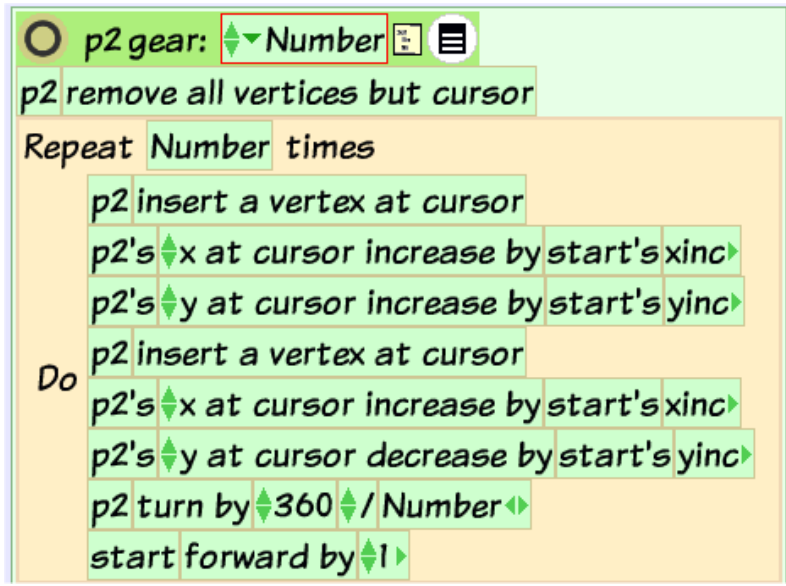
EToys Context

- EToys lacks
  - sophisticated data structures
  - mathematical functions
  - bitmap drawing primitives
- Use facilities that children can understand
- Avoid
  - trigonometry
  - vectors
  - calculus

Polygons

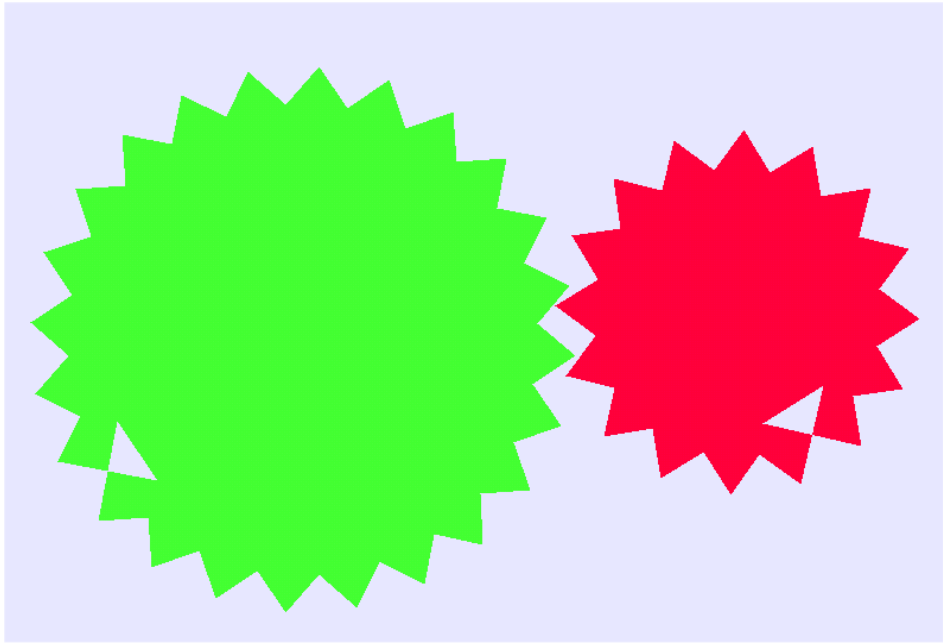
- Add a side
- Increment the X and Y coordinates
- Add a side
- Increment X, decrement Y
- Rotate



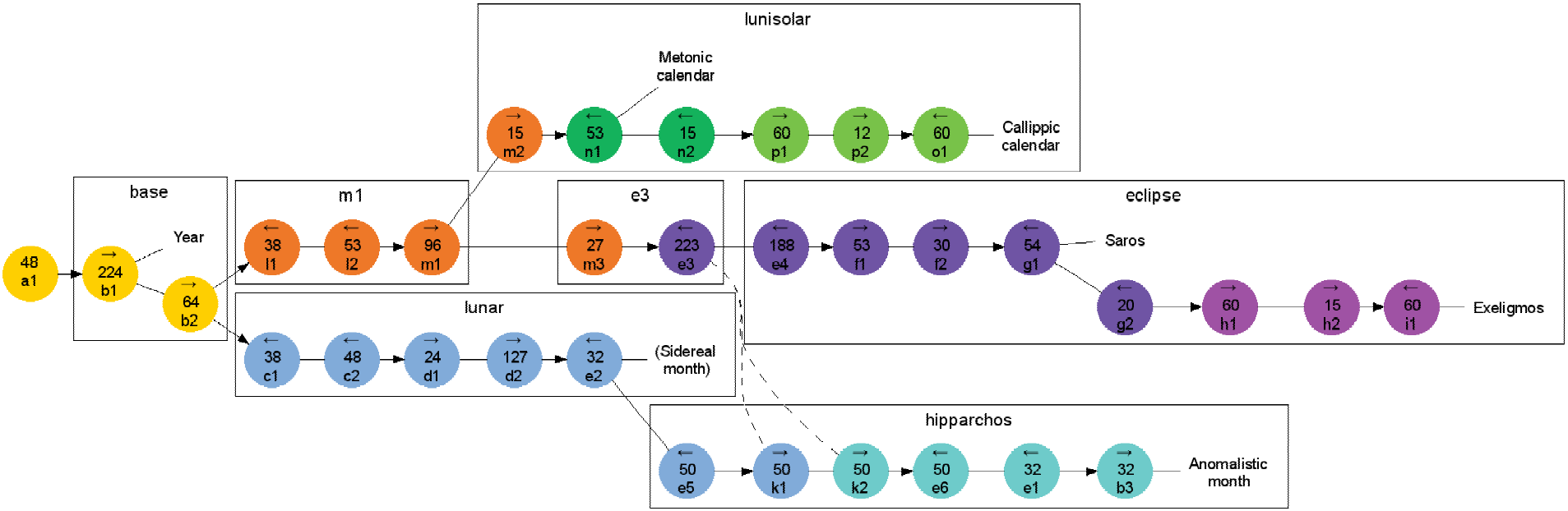


Calculating with Gears

- Gear A: 24 teeth
- Gear B: 16 teeth
- Ratio: 24/16 = 3/2



Functional Decomposition



Gear Placement

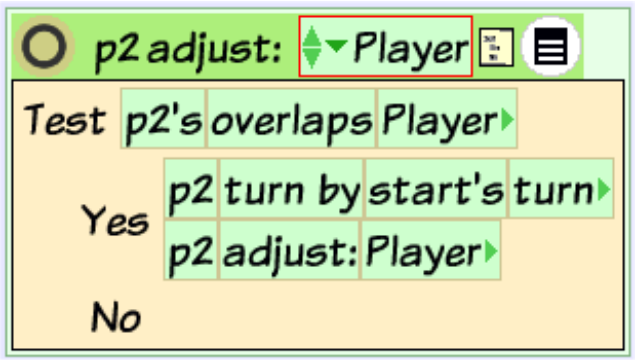
- North
- South
- East
- West
- coCenter

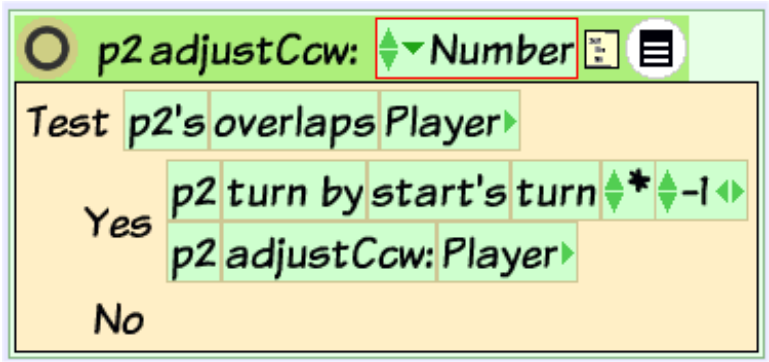
```
bl north: Player
bl movex: nil's x
bl movey: nil's top + start's delta + bl's length / 2
```

```
start luniSolarSetup ! normal
m1 east: l2
m1 west: l2
m2 gear: 15
m2 coCenter: m1
n1 gear: 53
n1 north: m2
n2 gear: 15
n2 coCenter: n1
p1 gear: 60
p1 north: n2
p2 gear: 12
p2 coCenter: p1
o1 gear: 60
o1 east: p2
```

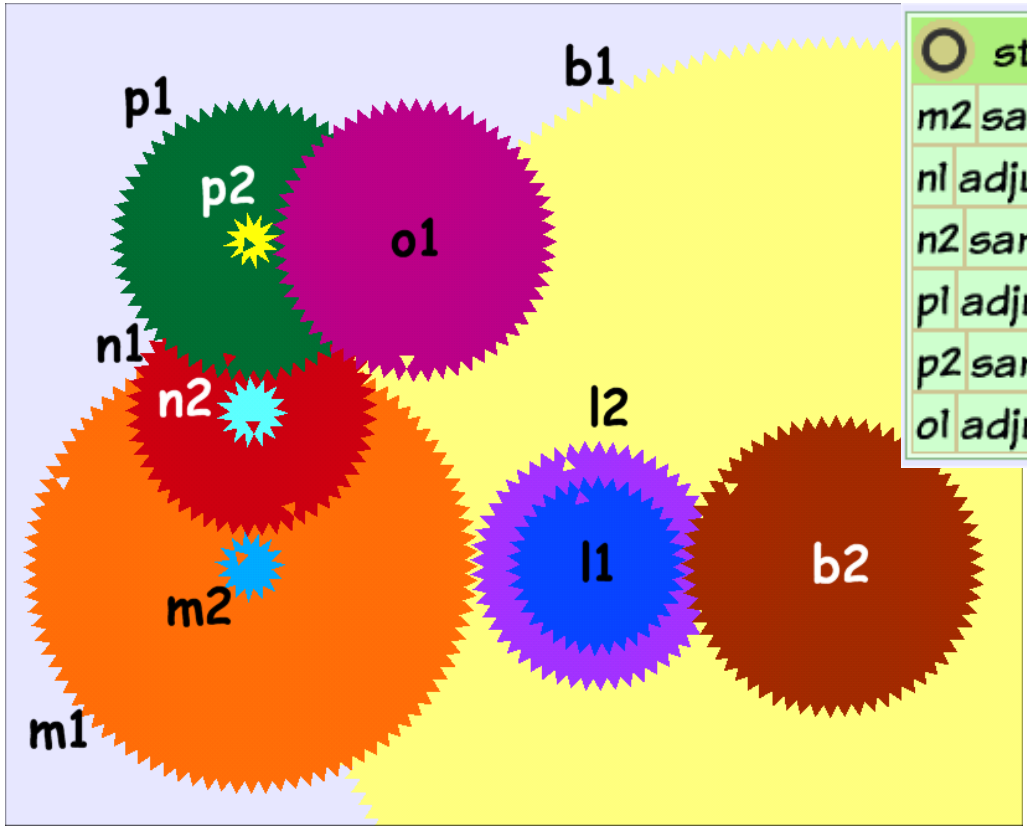
Gear Movement

- Concentric: maintain heading
- Engaged: rotate if overlapping



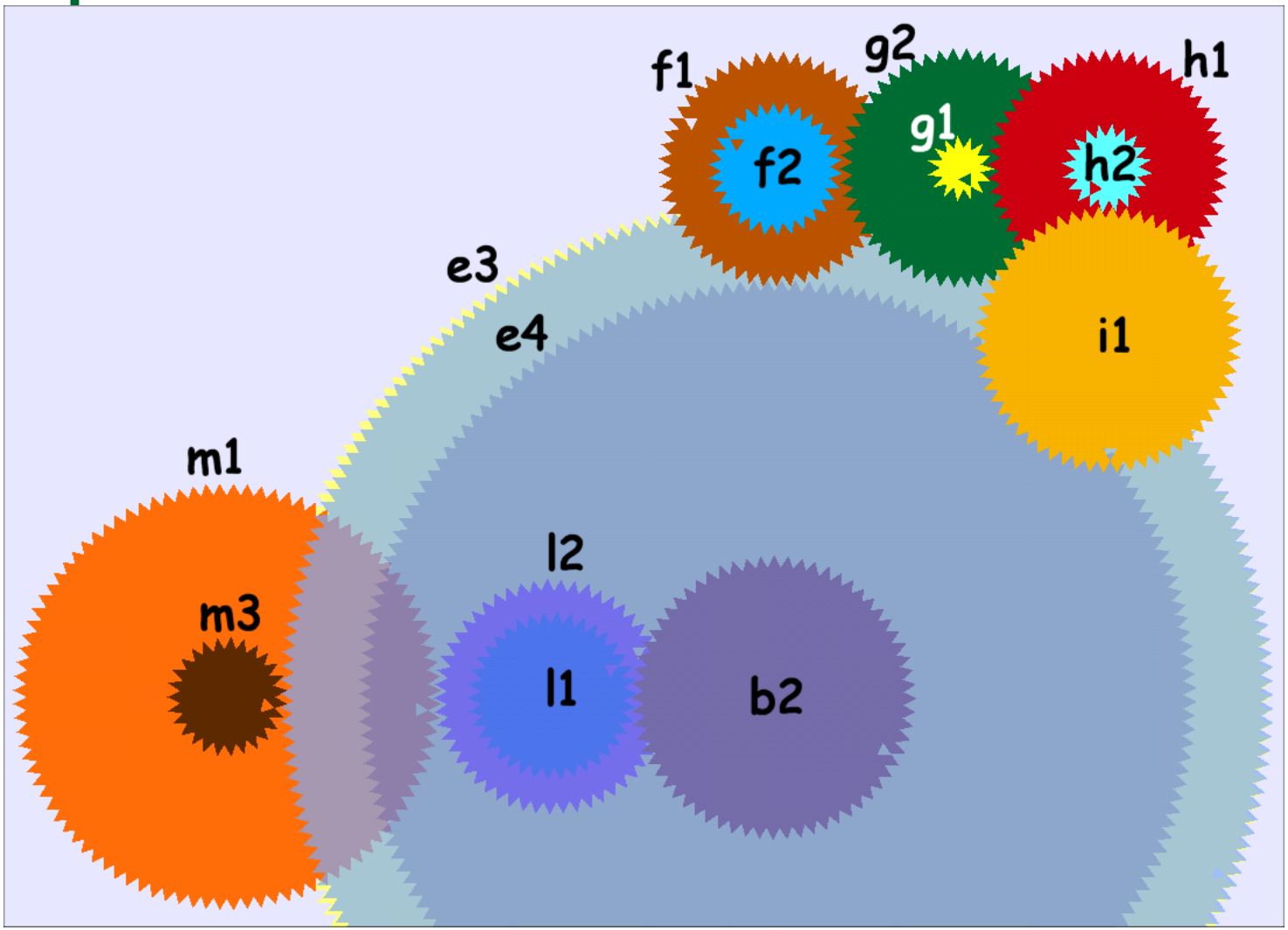


Example: Luni-Solar Calendar

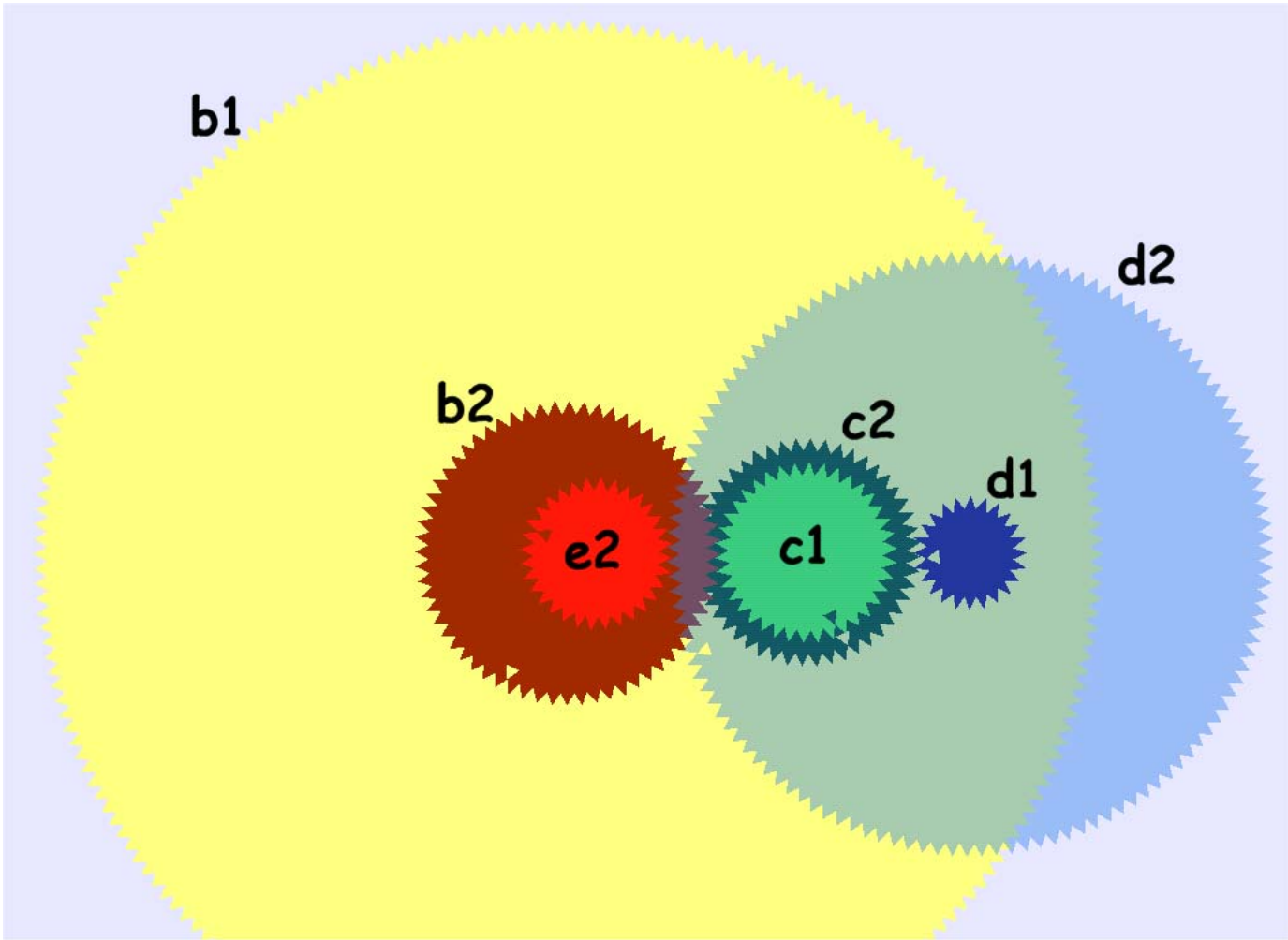



```
start luniSolarOperate ! normal
m2 sameHeading: m1
n1 adjustCcw: m2
n2 sameHeading: n1
p1 adjust: n2
p2 sameHeading: p1
o1 adjustCcw: p2
```

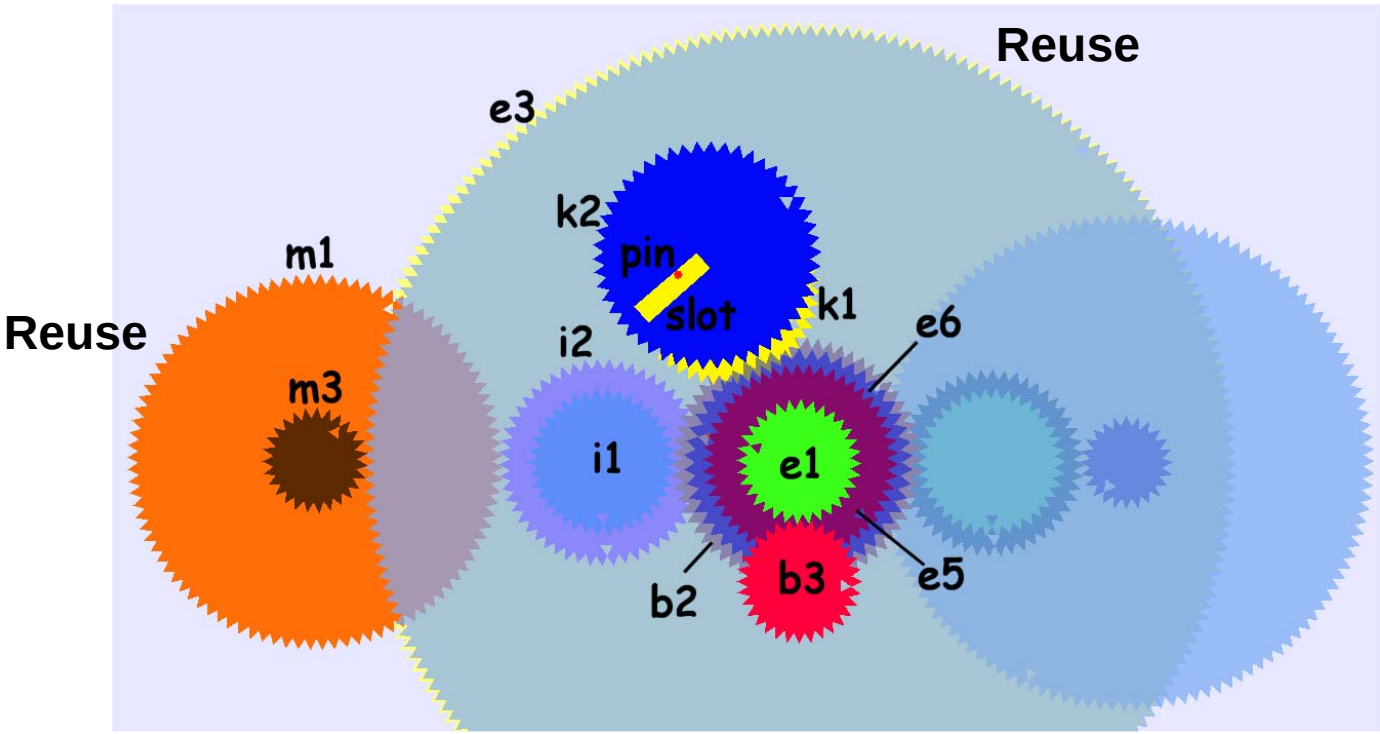
Eclipse Prediction



Sidereal Month



Hipparchos's Mechanism



Tens of Other Applications

Contact Details

Diomidis Spinellis

http://www.dmst.aueb.gr/dds

dds@aueb.gr

http://www.dmst.aueb.gr/dds/sw/ameso

http://www.laptop.org